CLAIMS

1. Apparatus for real-time dynamic analysis of chemical etching of a solid in a liquid etchant, comprising:

an optical element operative to pass a beam of electromagnetic radiation through said liquid etchant at at least two points in time;

a detector operative to perform *ex-situ* non-contact scanning detection over a predetermined spectral range of said beam of electromagnetic radiation, subsequent to said beam of electromagnetic radiation passing through said liquid etchant at said at least two points in time, so as to detect at least one change in at least one optical property of said liquid etchant; and

a processor operative to to compare said at least one change in said at least one optical property of said liquid etchant received from said detector so as to provide a rate of etching of said solid.

2. Apparatus according to claim 1 and wherein said optical element comprises:

i) an electromagnetic radiation source operative to emit said beam of electromagnetic radiation, and further configured to transmit a reference beam of electromagnetic radiation;

ii) a first optical transmission element operative to transmit said beam of electromagnetic radiation from said electromagnetic radiation source through a sampling element containing a sample of said liquid etchant; and

iii) a second optical transmission element operative to convey said electromagnetic radiation from said sampling element to said detector.

3. Apparatus according to claim 1, and wherein said processor is further operative to provide a rate of depletion of at least one chemical component of said liquid etchant over a period of time.

4. Apparatus according to claim 3, and wherein said processor is further operative to provide a derivative function of said rate of depletion of at least one chemical component of said liquid etchant.

5. Apparatus according to claim 2, wherein said sampling element comprises a substantially transparent tube.

6. Apparatus according to claim 5, and wherein said substantially transparent tube comprises a material transparent to said predetermined spectral range.

7. Apparatus according to claim 6, wherein said material comprises at least one of teflon, glass, polyethylene, polypropylene, PET, polyvinylchloride, nylon, Tygon, polystyrene, silicone rubber PVA, and quartz.

8. Apparatus according to claim 6, wherein said liquid etchant flows through said substantially transparent tube.

9. Apparatus according to claim 1, wherein said processor is further configured to convert a change in an optical property of a plurality of chemical components in said liquid etchant into a rate of change of a concentration of at least one of said plurality of chemical components.

10. Apparatus according to claim 1, and wherein said processor is operative to activate an algorithm to perform manipulations on said data using at least one of data: principal component analysis, partial least squares analysis, multiple linear regression analysis and neural network analysis.

11. Apparatus according to claim 1, further comprising a chemical correction system operative to replenish at least one chemical component in said liquid etchant so as to adjust said rate of etching.

12. Apparatus according to claim 1, wherein said processor is further operative to perform a chemometric manipulation.

13. Apparatus according to claim 1, wherein said predetermined spectral range is in a near infrared range (700-2500 nm).

14. A method for real-time dynamic analysis of chemical etching of a solid in a liquid etchant, comprising the steps of:

passing electromagnetic radiation from an electromagnetic radiation source through a liquid etchant, at at least at two points in time, wherein said liquid etchant is operative to etch said solid;

performing *ex situ* non-contact scanning detection over a predetermined spectral range of said electromagnetic radiation passed through said liquid etchant, by means of a detector over said at least at two points in time so as to detect at least one change in an at least one optical property of said liquid etchant;

comparing said at least one change in said at least one optical property at said at least two points in time by means of an algorithm in a processor so as to provide a rate of etching of said solid.

15. A method according to claim 14, wherein said passing includes:

i) emitting electromagnetic radiation in said predetermined spectral range from an electromagnetic radiation source;

ii) transmitting said electromagnetic radiation via a first optical transmission element from said electromagnetic radiation source through a sampling element containing a sample of said liquid etchant; and

iii) conveying output electromagnetic radiation from said sample of said liquid etchant via a second optical transmission element to said detector.

16. A method according to claim 14 wherein said comparing further comprises performing a chemometric manipulation on data relating to said at least one change in said at least one optical property.

17. A method according to claim 14, wherein said algorithm further provides a differential rate of change of said etching of said solid over a period of time.

18. A method according to claim 14, wherein said algorithm further provides a rate of depletion of at least one chemical component of said liquid etchant over a period of time.

19. A method according to claim 14, wherein said algorithm further provides a rate of

etching of said solid as a function of a concentration of said liquid etchant.

20. A method according to claim 14, wherein said liquid etchant comprises ions selected from the group consisting of halide ions, sulfuric ions, sulfurous ions, nitrous ions, nitric ions, and nitride ions.

21. A method according to claim 14, and wherein said passing further comprises passing said liquid etchant through a sampling element having a substantially transparent sampling tube.

22. A method according to claim 14, wherein said comparing step further comprises converting said at least one change in said at least one optical property of said liquid etchant into a concentration parameter of at least one chemical component of said liquid etchant.

23. A method according to claim 14, wherein said comparing step further comprises further comprises providing a concentration of at least one chemical component of said liquid etchant.

24. A method according to claim 23, wherein said comparing step further comprises supplying a rate of change of a concentration of said at least one chemical component.

25. A method according to claim 14, further comprising

a) obtaining a plurality of liquid etchant samples, wherein each sample of said plurality of liquid etchant has known etch rate;

b) irradiating said plurality of liquid etchant samples with NIR and recording their respective spectral scanning transmission intensities over said predetermined spectral range;

c) comparing variations of their respective spectral scanning transmission intensities over said predetermined spectral range so as to correlate spectral transmission of said plurality of samples with said known etch rate, wherein said known etch rate is determined by thickness measurements;

d) developing a calibration model based on the results of step (c);

e) measuring scanning spectral transmission over said predetermined spectral range of a further liquid etchant sample so as to determine at least one of an etch rate and a concentration of said at liquid etchant based on said calibration model.

26. A method according to claim 14, further comprising detecting a fault in a rate of addition of a replenishing chemical component of said liquid etchant.

27. A method according to claim 14, wherein said comparing step further comprises detecting a bubble in said liquid etchant.

28. A method according to claim 14, wherein said comparing step further comprises determining a concentration of at least one of a plurality of chemical components in said liquid etchant with a confidence level of more than 95%.

29. A method according to claim 28, wherein said method is independent of a presence of bubbles in said liquid etchant.

30. A method according to claim 28, wherein said method is independent of the temperature of said liquid etchant.

31. A method according to claim 14, further comprising the steps of:

applying computer software to data relating to said at least one change in said at least one optical property so as to provide an updated algorithm; and

applying said updated algorithm to data of to a new sample of said liquid etchant so as to further provide a rate of etching of said solid in said new sample.

32. A method according to claim 14, further comprising determining a concentration of at least one of the following: $HF:H_20$, HF1:5, HF1:50, BOE, $H2SO_4:HNO_3:HF$, EG+HF, Acetic Acid: NH_4F, $H3PO_4:HNO_3$:Acetic acid, $HNO_3:HF$, an acid, a base, a commercial oxide etchant, a commercial silicon etchant, a commercial metallic etchant, $H_2SO_4:H_2O_2$, $H_2SO_4:HNO_3$ and H_2SO_4:persulfate.

33. A method according to claim 14, wherein said predetermined spectral range is in a near infrared range (700-2500 nm).